Muon Facilities (Neutrino Factory) R&D

1. Introduction
2. Neutrino Factory R&D at Fermilab
3. World Context
4. National Context

INTRODUCTION

Fermilab and the Fermilab community are at center of both the ongoing national and international Neutrino Factory R&D efforts.

NOTE THAT

Fermilab hosts the US neutrino community. Neutrino Factories are the ultimate tool for studying neutrino oscillations and neutrino oscillation physics is exciting.

AND

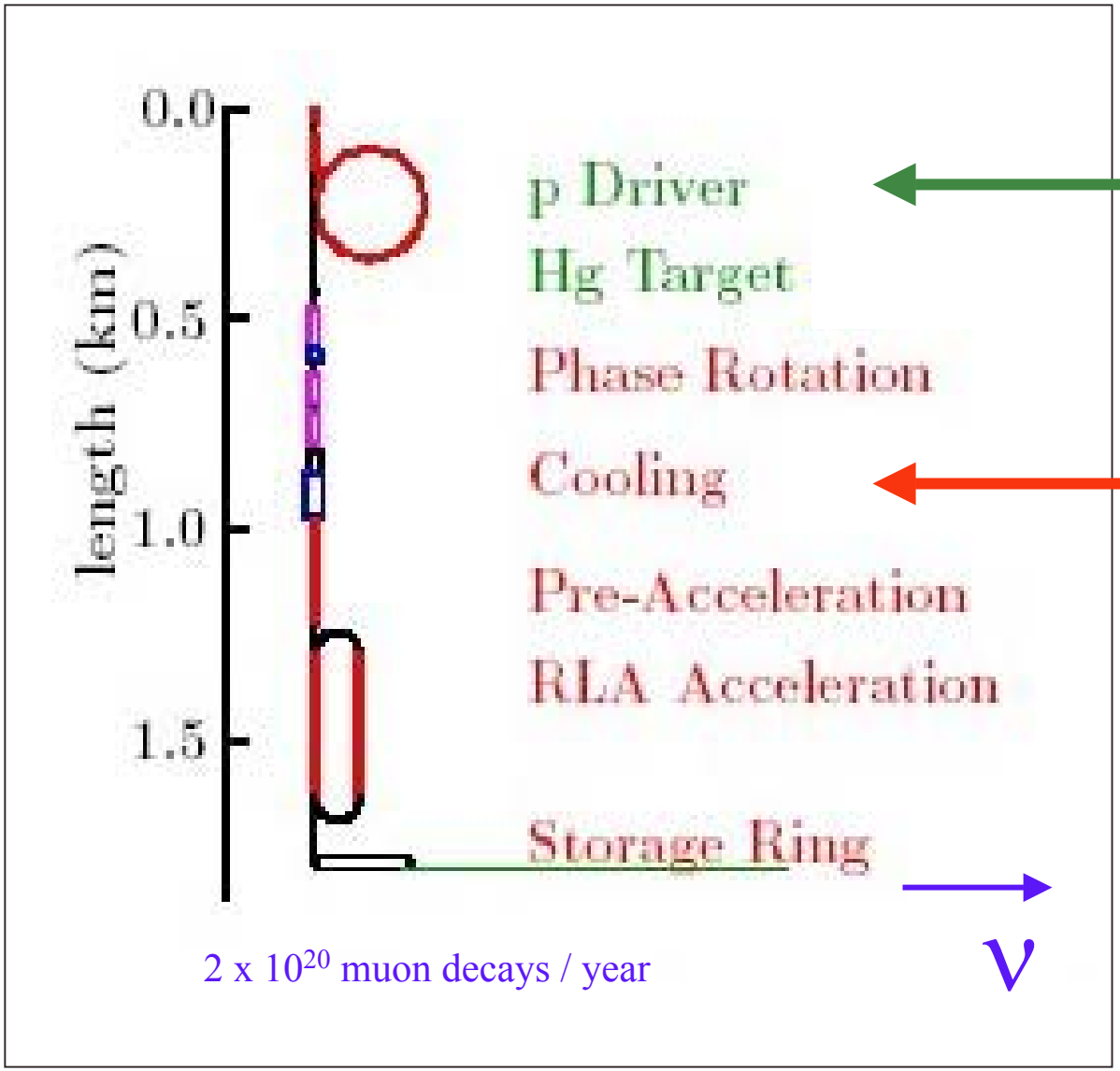
It is possible that a Neutrino Factory is somewhere in Fermilab's future (depending on how the neutrino oscillation program evolves, the eventual location of the Linear Collider, …).

Neutrino Factory R&D at Fermilab

Fermilab's Neutrino Factory R&D effort is focused on the development of a muon ionization cooling channel → MUCOOL Collaboration→ 70 Scientists from 16 Institutions. MUCOOL is organized much like a particle physics experiment → Alan Bross's talk.

At Fermilab we also have a small (~2 FTEs) investment in Neutrino Factory design. Although the effort is modest, its impact on the Neutrino Factory design ideas is substantial → Dave Neuffer's talk.

NEUTRINO FACTORY DESIGN



Proposed FNAL Proton Driver Upgrade could be used for a Neutrino Factory

Fermilab hosts the muon cooling channel R&D – MUCOOL Collaboration

Fermilab community is making key contributions to the Neutrino Factory design effort.

WORLD CONTEXT - Coordination

Neutrino Factory R&D is becoming increasingly international. "Grass-Roots" coordination is through annual NUFACT international workshops (rotates: US, Europe, Japan) and international steering groups.

NUFACT01: Launced a grass roots international steering group to initiate the international Muon Ionization Cooling Experiment (MICE) Collaboration.

NUFACT03: Launched a grass roots international steering group to co-ordinate the preparation for the "World Neutrino Factory Design Study" (there is a bid for EU funds to support the study).

Neutrino Factory R&D at Fermilab is being pursued very much in the context of these international efforts.

WORLD CONTEXT - MUCOOL

MUCOOL already has European and Japanese participation. The MUCOOL goal is to develop &make engineering tests of all cooling channel components.

The international Muon Ionization Cooling Experiment (MICE) will use these MUCOOL components to demonstrate a short cooling section in a muon beam at the Rutherford Lab.

MUCOOL & MICE have been identified by our external technical review committee as providing "the critical systems test that must be made before a Neutrino Factory could be built".

MICE has just received scientific approval. MUCOOL R&D is on the critical path for MICE, and MICE is on the critical path for a Neutrino Factory.

MICE Approval

130 Scientists from Europe, US, and Japan

CCLRC

Professor Alain Blondel
Neutrino Physics Group
Département de Physique
Nucleaire et Corpusculaire
Université de Genève
Quai Ernest-Ansermet 24
CH-1211
Geneve 4
Switzerland

&

Professor Dan Kaplan
Department of Physics
Imperial College London
Prince Consort Road
LONDON SW7 2BZ

Our Ref: JVW/ cid/MICE2 2003-10-24

24 October 2003

Dear

The last few months have seen the international MICE project proposal peer reviewed at both a national and an international level. The scientific case, technical merits and timeliness of the proposal have been strongly endorsed in each case. CCLRC accepts the strong endorsement of the proposal by the Astbury panel and consequently considers the proposal to have full scientific approval.

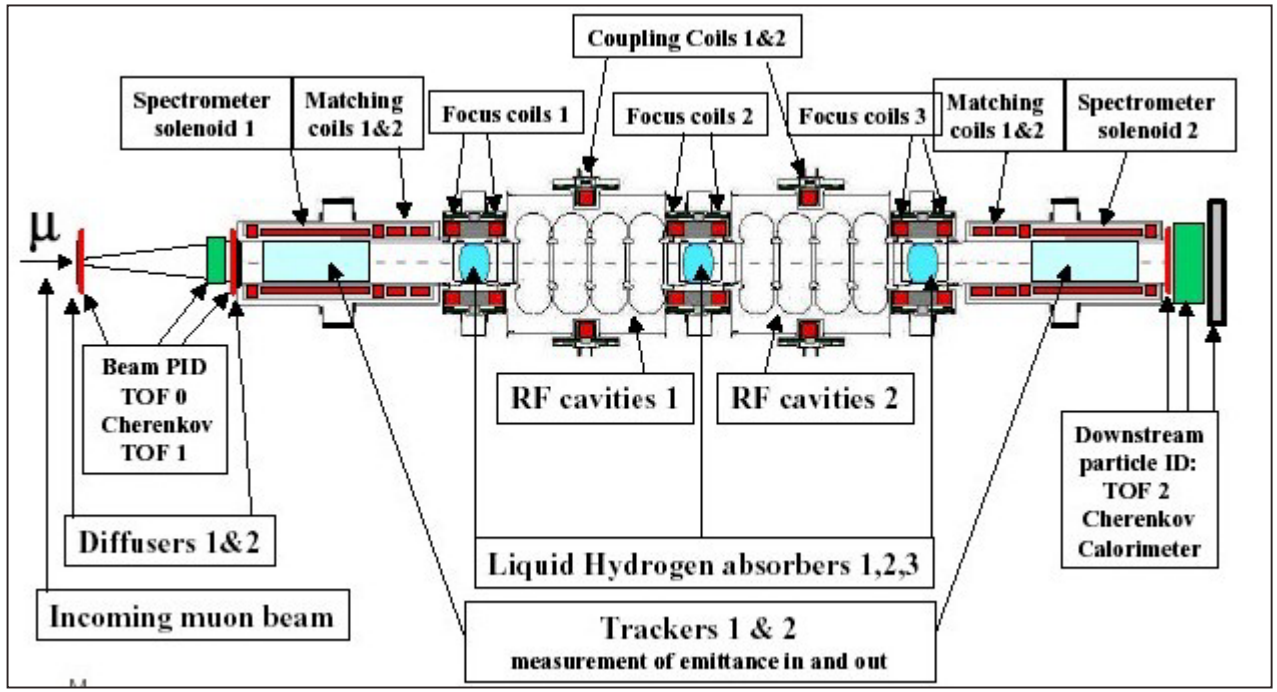
Progress of the project is now dependent on satisfactory funding arrangements being in place together with an appropriate project management structure. These arrangements will require scrutiny to ensure "best value" for UK and other investors. Within the UK this will be ensured by an independent review through the "Gateway" process that will be managed by the Joint MICE Project Board.

CCLRC therefore approves the project subject to a satisfactory progress through Gateway. The MICE proponents are now encouraged to actively seek funds to support MICE.

Yours sincerely

Professor J V Wood
Chief Executive

Cc Professor Ian Halliday, PPARC
Professor Ken Peach, CCLRC



The last few months have seen the international MICE project proposal peer reviewed at both a national and an international level. The scientific case, technical merits and timeliness of the proposal have been strongly endorsed in each case. CCLRC accepts the strong endorsement of the proposal by the Astbury panel and consequently considers the proposal to have full scientific approval.

WORLD CONTEXT – DESIGN STUDY

In the US there have been 2 Neutrino Factory Design studies, hosted by Fermilab and BNL respectively, each study with ~1M$ engineering.

Studies 1 and 2 showed that a Neutrino Factory is feasible, and helped define the R&D program required before a Neutrino Factory can be built.

In the next couple of years we hope to launch a World Design Study ("Study 3") with a focus on cost optimization. The Rutherford Lab is a candidate host laboratory.

Progress towards Cost Reduction

Study 2 Design: ¾ of the cost in 3 roughly equally expensive systems:

	Study 2	Now	Factor
Tot Length (m)	328	166	51%
Acc Length (m)	269	35	13%
Acc Type	Induction	Warm RF	

Phase Rotation

	Study 2	Now	Factor
Tot Length (m)	108	33	30%
Acc Length (m)	54	37	21%
Acc Grad (MV/m)	16	12	66%

Cooling Channel
(Linear channel→ Ring)

	Study 2	Now	Factor
Vac Length (m)	3261	1094	34%
Tun Length (m)	1494	1094	49%
Acc Length (m)	288	102	35%
Acc Grad (MV/m)	16	8	50%

Acceleration
RLA → FFAG

Fermilab contributions are at the center of all of these new ideas

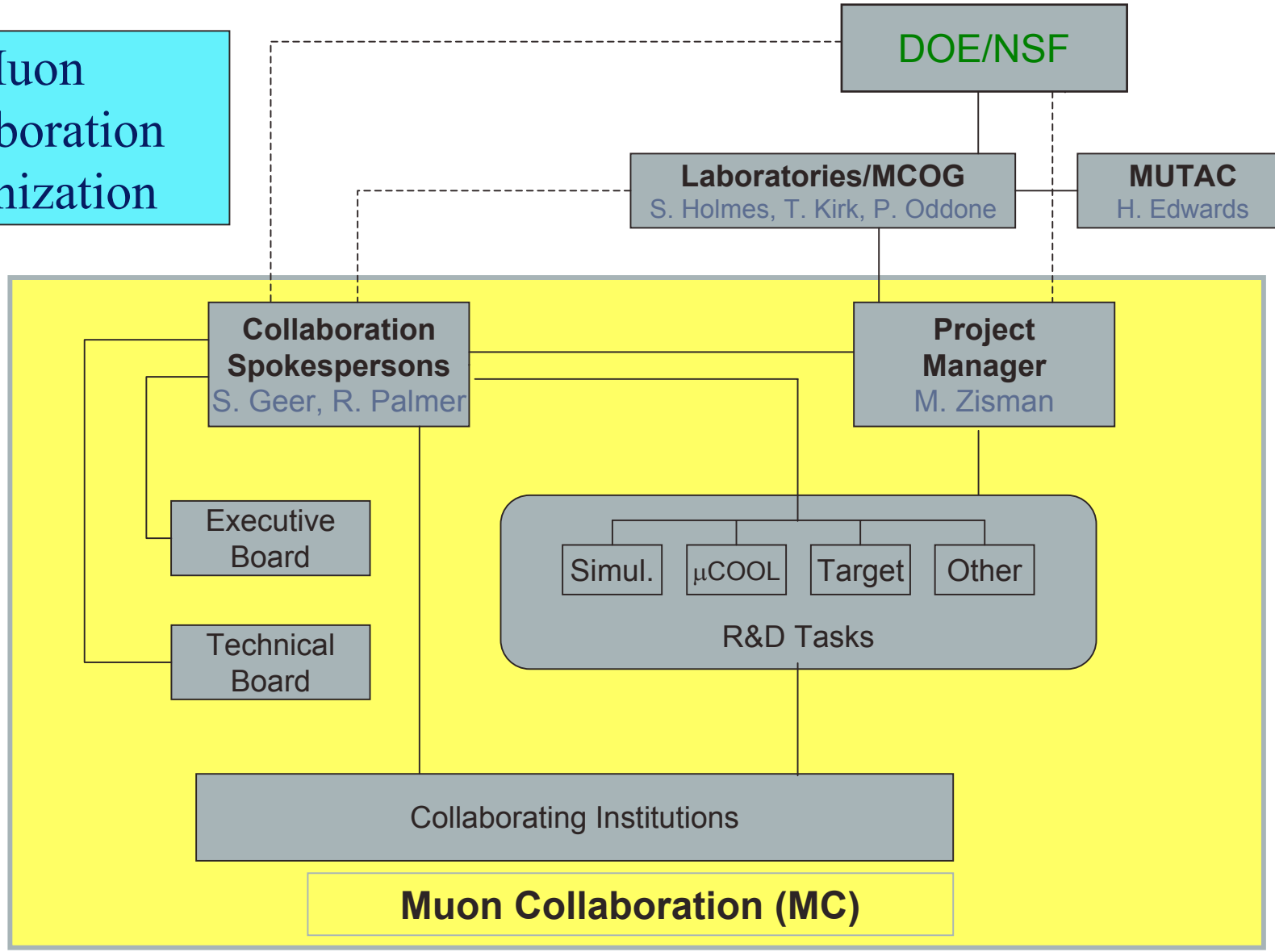
National Context

Both MUCOOL and the design effort are a part of the Neutrino Factory and Muon Collider Collaboration (Muon Collaboration) → 130 scientists.

Oversight for the Muon Collaboration activities is provided by a Directorate-Level oversight group (MCOG). MCOG appoints an external technical review committee (MUTAC).

Every year the Muon Collaboration undergoes a 2 day external technical review by the MUTAC committee.

Muon Collaboration Organization



(130 Members)

2002 HEPAP Subpanel Recommendation

Accelerator R&D

"We give such high priority to accelerator R&D because it is absolutely critical to the future of our field. … As particle physics becomes increasingly international, it is imperative that the United States participates broadly in the global R&D program."

Neutrino Factory & Muon Collider R&D

"We support the decision to concentrate on intense neutrino sources, and recommend continued R&D near the present level of 8M$ per year. This level of support is well below what is required to make an aggressive attack on all of the technological problems on the path to a neutrino factory."

MUTAC Review – October 2001

Every year the Muon Collaborations R&D is reviewed by an external technical committee (MUTAC: H. Edwards (chair), M. Breidenbach, G. Dugan, M. Harrison, J. Hastings, Y.-K. Kim, J. Lykken, A. McInturff, R. Ruth, K. Yokoya), who report to a multi-laboratory directorate level oversight group (MCOG).

The MUTAC report was very positive. The MUTAC report received a strong letter of transmittal from our oversight group (MCOG = representatives from BNL, LBNL & FNAL Directorates):

" The impressive record of progress is epitomized by the summary judgment of the report, namely, that
The committee finds the progress since last year excellent. "

MUTAC Review – January 2003

The review this year was in January, and resulted once again in a very positive report. In their transmittal letter to the laboratory directors, MCOG say:

The successful record of progress is epitomized by the summary judgment in the report, namely that "Overall, MUTAC was impressed by the accomplishments since the last meeting, particularly given the strained financial situation. MUTAC can enthusiastically assure MCOG that the limited funding is being well and carefully utilized."

MCOG has concluded that it is imperative that DOE seek to provide enhanced R&D funding for this work if it is to meet either the intent or the recommendations of the Long Range Plan laid out in the 2002 Gilman Report of HEPAP.

MCOG Recommendations to the DOE (Spring 2003)

1. In the area of experimental work, the highest priority should continue to be accorded to the 800 MHz and 200 MHz RF work, especially the testing of the 800 MHz cavity in a magnetic field. This work is critical to the advancement and eventual success of the MUCOOL and MICE projects. High power target R&D is important to a number of future high energy accelerator projects under consideration in the U.S. program and this work should be continued.

2. MCOG supports participation by the U.S. in the Muon Ionization Cooling Experiment (MICE) and urges DOE to support this valuable international activity.

3. The creative conceptual advances made by the Muon Collaboration are strengthening the notion that a muon-storage-ring-based neutrino factory is feasible and will offer opportunities for a future facility. As such, we recommend continued support for conceptual development activities in parallel with the strengthened experimental and engineering R&D activities described above.

Summary

The Neutrino Factory R&D at Fermilab is focused on the development of a muon ionization cooling channel – identified by both MUTAC and the European oversight group (EMCOG) as the critical system to be developed before a neutrino factory can be built.

There is also a small, but very significant, Neutrino Factory design activity at Fermilab aimed at developing a cost effective design.
We wish to contribute to the "World Design Study".

The MUCOOL R&D is on the critical path for the newly approved international MICE experiment.

MCOG recommends: "… continued support for conceptual development activities in parallel with the strengthened experimental and engineering R&D activities "